

Mass.
HOUSE

. . . . No. 25.

SPECIAL REPORT

OF THE

STATE BOARD OF AGRICULTURE

ON THE WORK OF

EXTERMINATION OF THE OCNERIA DISPAR
OR GYPSY MOTH.

ACTS OF 1891, CHAPTER 210.

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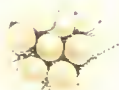
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EXPLANATION OF PLATE I.

GYPSY MOTH (*Ocneria dispar*, L.)

- Fig. 1. — Female with the wings spread.
2. — Female with the wings folded.
3. — Male with the wings spread.
4. — Male with the wings folded.
5. — Pupa.
6. — Caterpillar. } Full grown.
7. — Caterpillar. }
8. — Cluster of eggs on bark.
9. — Several eggs enlarged.
10. — One egg greatly enlarged.

THE GYPSY MOTH.

To the Senate and House of Representatives of the Commonwealth of Massachusetts.

The State Board of Agriculture, in accordance with the provisions of chapter 210, Acts of 1891, presents its report of transactions and expenditures.

As the Board is by law made the successor of the Gypsy Moth Commission, it seems proper that an allusion should be made to the original commission, the appointment of the second commission, and the method of transfer to this Board. By an act approved March 14, 1890, the Governor was "authorized to appoint a commission to provide and carry into execution all possible and reasonable measures to prevent the spreading and secure the extermination of the *Oeneria dispar* or gypsy moth, in this Commonwealth." By the same act twenty-five thousand dollars was provided for the work. Under this act three commissioners were appointed, and commenced work about April 1, 1890. The Legislature made an additional appropriation of twenty-five thousand dollars, which was approved June 3, 1890.

These commissioners continued in office until Feb. 15, 1891. On March 4, 1891, N. S. Shaler and Francis H. Appleton, members of the Board of Agriculture, and Wm. R. Sessions, secretary of said Board, were appointed commissioners. The new commission organized and acted as such until it was superseded by the Board of Agriculture. Chapter 210, Acts of 1891, was approved April 17, 1891. This act placed the work in the hands of the State Board of Agriculture, with all the powers and duties which previous legislation had conferred upon the commissioners, and also provided that "All moneys heretofore appropriated and authorized to be expended . . . and not heretofore expended are hereby appropriated and authorized to be expended by said Board in carrying out the purposes of this act." It also provided that "All the property acquired, and records kept

under provisions of said chapter 95 of the Acts of the year 1890 shall be delivered into the custody of said Board, and said Board is authorized to take, receive and use the same for the purposes of this act." Section 8 of chapter 210, Acts of 1891, provided that "The said State Board of Agriculture may exercise all the duties and powers herein conferred upon said Board by and through its secretary and such members of said Board as it may designate and appoint to have in charge, in conjunction with its secretary, the execution of the purposes of this act."

At a meeting of the Board of Agriculture, April 28, 1891, called for that purpose, Wm. R. Sessions, N. S. Shaler and Francis H. Appleton were chosen "a committee with full powers to exercise all the duties and powers conferred upon the Board of Agriculture by an act to provide against the depredations of the insect known as the *Ocneria dispar* or gypsy moth, known as House Bill No. 228." Thus the same men who had since March 4th acted as a commission in the gypsy moth work were appointed under the law to act for the Board of Agriculture. As a consequence, the work of the Board carried on by the committee was a continuation of the work of the commission, and therefore it is necessary that the work of the second commission should be noticed as preliminary to the report of the work of this Board. By enquiring of the auditor, it was ascertained that there was remaining unexpended of the appropriation of last year \$24,460.68. This sum was available for the work of the commission.

The members of the first commission were consulted. They gave the new commission such information as they had obtained as to the extent of territory infested, the method pursued by them in their last season's work, and turned over the property and records. Prof. C. V. Riley, entomologist of the United States Department of Agriculture, Prof. C. H. Fernald of the Agricultural College, Prof. Samuel Henshaw of the Boston Natural History Society, and Prof. S. H. Scudder of Cambridge, expert entomologists, were invited to meet with the commission and consider the conditions and the work to be done, and give advice as entomologists. They all accepted the invitation, and met with the commissioners early

in March. Their opinions and advice were asked and freely given. The mayors of cities and chairmen of selectmen of towns in the infested territory were also invited to be present at the meeting. Most of these officers were present. Their opinions on the situation and conditions in their several localities were secured by the commission.

Mr. E. H. Forbush of Worcester was appointed director of field work, March 12, 1891. Mr. Forbush is a naturalist of reputation and experience. He had been for several years president and managing director of the Worcester Natural History Society, and president of the Worcester Summer School of Natural History. The commission was obliged to secure his release from an engagement for scientific work in order to obtain his services.

Efforts were immediately made by the director and commission to procure suitable men for the work. Several were engaged from among the students of the Agricultural College, and most of them proved to be efficient and valuable assistants. The force was increased as suitable men could be obtained, and the surrounding country was carefully examined for the eggs of the moth, to the end that the extent of the infested territory might be known with certainty. It was found that the insect had secured a foothold in twenty cities and towns, and that Medford, Malden, Everett and parts of Somerville, Arlington, Melrose and Cambridge were thoroughly infested. When the caterpillars appeared, spraying was commenced with a large force of men and teams equipped with hogsheads of Paris green and water, pumps, hose, ladders, oil suits, etc., — an extensive and expensive outfit.

Meantime, chapter 210, Acts of 1891, had become a law; and the committee of the Board of Agriculture above named organized on May 19, 1891, by choosing Wm. R. Sessions, chairman and secretary, and assumed control in the name of and for the State Board of Agriculture. The sum of \$11,003.22 only remained of the previous appropriations. The appointment of E. H. Forbush as director of field work by the commission was confirmed and continued by the committee, and the plans formed by the commission were also approved and adopted, and the committee directed that the

work in progress should be continued. To prevent the transportation of caterpillars by teams, a large force of police was employed to guard the roads leading from the infested territory; but it was found impossible to make their work effective, and other means were resorted to to overcome the danger of spreading by transportation.

A code of rules and regulations was adopted, a copy of which is appended to this report. On June 3rd an additional appropriation of \$50,000 for the work was made by the Legislature. The force was immediately increased, and the work of spraying pushed with all possible rapidity. More than thirty teams and not less than two hundred and thirty men were employed. This work was continued until the caterpillars had so far ceased to feed that the spraying had little effect upon them. Vast numbers were destroyed by the spraying; but, from the fact that they were hatching all through the season, and the larvæ in all stages of growth were present at the same time and also that many had changed into the pupa stage before the latest hatching had been completed, it was found that spraying could not be depended on to kill them all. Their habit of spinning down when disturbed, and crawling away into the grass or other concealed situations, also prevents complete destruction by spraying.

On June 18th, Prof. Chas. H. Fernald of the Massachusetts Agricultural College was appointed entomological adviser to the committee, and was requested to at once critically examine the field work of the committee, and make a written report thereon, with suggestions and advice for the future. This was done by the professor, and since then he has from time to time visited the infested territory and inspected the work, directing experiments and advising as to the work in progress, and making a written report of each visit. At the suggestion of Professor Fernald the director and all the force were directed to watch for parasites preying upon the insect in its various stages. As a result, several such parasites were discovered. Professor Fernald advised that these native parasites be observed and experimented with before incurring the expense of importing others from Europe, the indications being that the natives might be able

to render all the assistance that could be expected from parasites.

When spraying ceased, every effort was made to destroy the creatures during the short time they remained in the pupa and moth stages. The men were then set to gathering and destroying eggs. It was found that in the section where they were most plentiful in the spring there were comparatively few, not more than one-tenth the number there were last spring. An effort was made to go systematically over the entire territory, gathering the eggs; but, as only the most trustworthy men, who were also careful observers, could be relied upon to do the work, it was necessary to reduce the force by discharging all others. The progress was necessarily slow, as every tree, shrub, wall, fence, pig-pen, hen-house, shed, and even houses and barns, in the most thickly infested territory had to be carefully examined by the men, and afterwards inspected by the most expert among them. In doing this work use was made of every possible method to save time and expense. Old stone walls were burned out by the use of crude petroleum. The oil was forced among the stones in the form of a spray, by the use of pumps and spraying nozzles. Large tracts of land covered with brush were burned over after the brush had been cut and sprayed with petroleum, and in some cases woodland was cut and burned over after the wood worth saving had been examined and removed. The task undertaken proved a costly one, and it was found that the appropriation made by the last Legislature would be insufficient to complete the work. The committee believed that they ought to be able to inform the Legislature with certainty as to the extent of territory which had been invaded by the moth. So, about the 20th of November, the leaves having fallen, the whole force was put to work carefully inspecting the towns surrounding the territory in which the moth was found at the time of the spring inspection. This work has just been completed. The eggs of the moth were found in a very few places outside of the territory where it was found in the spring, but in no such case were they found in any considerable numbers.

The committee believes that the work of gathering the eggs throughout the entire district infested should be completed in the most thorough manner before the appearance of the leaves next spring. If this can be accomplished, we believe that the number of caterpillars that will appear in the spring will be comparatively small, and that they will be so much scattered that they can be found and destroyed without the spraying of the trees and shrubs of the whole country. The work of spraying is very expensive, and many owners of property are much opposed to having it done on their premises. If this systematic egg-gathering is to be completed as above recommended, a large force of sharp and reliable men must be set at work at once. The appropriations granted by the last Legislature are almost exhausted, and this work cannot be begun until the present Legislature provides the means. With prompt and liberal provision for the next season's work the committee believes that decided progress can be made in the task Massachusetts has undertaken, to wit, "To prevent the spreading and to secure the extermination of the *Oenaria dispar* or gypsy moth in this Commonwealth."

The committee believes that an appropriation of seventy-five thousand dollars will be needed to carry on the work according to the plans laid out for 1892. For details of the work of the past season we beg to refer you to the reports of Prof. C. H. Fernald, entomological adviser of the committee, and of Mr. E. H. Forbush, director of the field work, which are transmitted with this report.

The following is a statement of the expenditures of the Board of Agriculture by their committee.

WM. R. SESSIONS,

Secretary of the Board of Agriculture.

FINANCIAL STATEMENT — 1891.

1891.

January 1.	Amount on hand,	\$24,460 68	
	Amount expended by old com- mission,		\$630 95
	Balance,		23,829 73
April 1.	Balance on hand,	\$23,829 73	
	Amount expended by new commission, . . .		12,826 51
	Balance,		11,003 22
		<u>\$23,829 73</u>	<u>\$23,829 73</u>
May 19.	Balance on hand,	\$11,003 22	
	Appropriation,	50,000 00	
	Expenditures by the State Board of Agriculture:		
	Wm. R. Sessions, expenses,		\$22 28
	N. S. Shaler, expenses,		74 25
	Francis H. Appleton, ex- penses,		25 00
	E. H. Forbush, director,		1,500 00
	C. H. Fernald, entomologist, remuneration and ex- penses,		280 84
	Assistant entomologist and mi- croscopist,		595 08
	Book-keeper,		504 62
	Purchase of horse, buggy, etc.,		291 25
	Legal expenses,		50 00
	Travelling expenses of inspect- ors and men,		840 14
	Insecticides,		1,108 12
	Teaming, etc.,		5,252 93
	Wages of men,		39,997 16
	Supplies and tools,		5,248 42
	Balance,		5,213 13
		<u>\$61,003 22</u>	<u>\$61,003 22</u>

TOTAL AMOUNT EXPENDED IN 1891.

Old commission,	\$630 95
New commission,	12,826 51
Board of Agriculture,	55,790 09
Total,	<u>\$69,247 55</u>

RULES AND REGULATIONS OF THE GYPSY MOTH COMMITTEE.

1. All persons are forbidden by law to remove the gypsy moth, its nests or eggs, from one place to another, in any city or town, and are requested to exercise care against so transporting the gypsy moth on teams and carriages.

2. All persons are forbidden to remove from the present locality in the towns of Medford, Everett, Chelsea, Malden, Melrose and Arlington, any hay, manure, wood, bark, trees, rags, lumber or shrubbery of any kind, without a written permit from the department. All loads must be well covered with canvas covers.

3. All persons are forbidden to in any way imitate or erase the marks employed by this department to designate trees, fences or buildings, which are infested or have been cleaned.

4. All vehicles leaving the above-named district may be stopped by the officers of the department, and delayed until their contents have been sufficiently inspected to determine the fact that they are not liable to transmit the eggs or any other form of the insect.

5. No person shall remove the bark from trees, nor attempt to scrape and clean them, without first notifying this department, and having said trees thoroughly inspected, and, if found infested, cleaned under its direction. The eggs of the gypsy moth are frequently scattered abroad by scraping the trees and by careless gathering; therefore, all persons except the authorized agents of this department are forbidden to remove the eggs of the gypsy moth from trees or other objects upon which they may have been deposited. Real estate owners and tenants are requested to destroy *all other forms* of the moth which they may find upon their premises.

6. All persons, upon notice, are required to confine their dogs while the agents of this department are at work upon their premises.

7. Owners or tenants are requested to gather and burn all rubbish and useless material upon their premises that may provide nesting places for the insect, and to fill with cement or other solid material all holes in trees upon their premises.

8. All persons are requested to keep the windows of their houses protected by screens during the summer months, as it is found the insect often lays its eggs in the houses, wherever it can gain admittance.

9. All persons having reasonable cause to believe that the eggs, caterpillars or other forms of the gypsy moth exist on or about



Trees stripped by caterpillars of the Gypsy Moth.

ARLINGTON, MASS., JULY 9, 1891.

their premises, are earnestly requested to forthwith notify E. H. Forbush, director, by letter addressed to his office in Malden, Mass. Information of their existence in isolated or unexpected localities will be gratefully received, and all persons furnishing such information will receive the thanks of the department.

10. Notice is hereby given that it will, in some cases, be necessary to remove boards from fences or buildings. In all cases they will be eventually replaced, if possible, without damage to the structure. Attention is called to the fact that any damage done by the agents or servants of this department, in the work of exterminating the moth, may be recovered under provisions of section 2, chapter 210, Acts of 1891. Attention is also called to section 6 of said act, which sets forth the penalties for obstructing any servant or agent of the State Board of Agriculture under this Act.

11. Courteous and considerate conduct is expected of all agents and employees of the department. Complaints in writing concerning any infraction of this rule should be sent to the director, and will be heard by him or the Committee.

WM. R. SESSIONS,

N. S. SHALER,

FRANCIS H. APPLETON,

Committee of State Board of Agriculture.

FIELD DIRECTOR'S REPORT.

To the Committee on the Gypsy Moth.

GENTLEMEN: Your director of field work was appointed March 12, 1891. The next day he went to Amherst, and there engaged nine students of the Massachusetts Agricultural College to act as inspectors. These young men were highly recommended by the president and faculty of the college, and were selected on account of their fitness for the work. The next step was a consultation with Prof. C. H. Fernald of the Hatch Experiment Station at Amherst, entomologist of the State Board of Agriculture. It was largely upon his recommendation that several of the best men were employed, and from that time on his advice and assistance were always freely sought and as freely given. The plans of the director were from time to time perfected by a careful consideration of his recommendations.

In the meantime an office was opened, and measures were taken to secure workmen. The district then known to be infested was hastily inspected by the director. Maps were secured and divided into sections, and a plan of action was made. The men arrived at the office of the State Board of Agriculture on Thursday,

March 19, received instructions, and then went to Malden. On Friday, March 20, sixteen men were in the field.

Organization. — Beginning of Section Work.

It was at once seen that the work of crushing out the species would be an arduous task. For an undertaking of this character and magnitude, men were needed who by nature and training were fitted for the work. A perfect system was imperative. An intimate acquaintance with the country must be acquired. An accurate knowledge of the habits of the insect was a necessity, and constant vigilance an indispensable requisite.

When field operations were commenced, the eggs of the gypsy moth were the only living form of the pest. The men were carefully trained to recognize and destroy them, and to distinguish between their eggs and those of our native moths. They were taught to observe all evidences of the existence of the gypsy moth, and were requested to secure all information possible in regard to its habits. Each inspector was instructed to make out a daily written report of the work done by himself and his men, and to include in this report his observations on the habits of the insect. Many valuable facts were thus recorded during the season. As the force was organized, each inspector was given a squad of men, and a section, indicated by a map, was allotted him, with instructions to inspect it, and destroy the eggs therein. When eggs were found upon a tree, the tree was marked with white paint and the locality designated upon the map. Special implements for the work were invented as necessity required, and a stock of equipments and material was gradually accumulated.

At this time the gypsy moth was supposed to be confined to eight or nine towns. Inspectors were sent out to determine how far it had extended, and soon found small colonies in other towns. It was at once evident that inspection must be continued until the limits of the infested district were determined. This method was followed until the new leaves covering the trees rendered further inspection impracticable. The work was resumed when the caterpillars had nearly reached maturity, was continued after the leaves fell, and is still in progress.

After the men had received the training and experience without which their work would have been of little value, there remained but six weeks in which to make a hasty inspection of the territory and destroy the eggs. Although the work was thus necessarily hurried and imperfect, yet, in consequence of it, the insects have not since appeared in more than sixty localities where the eggs were found in the spring. The infested towns farthest from the

centre were first visited by the men engaged in destroying eggs. The men worked from these towns toward Malden and Medford. Before this work was completed the eggs began to hatch. This rendered thorough work an impossibility. No attempt was made, therefore, in the spring, to complete this work in Malden and Medford, except upon trees on or near the highways.

Cutting and Burning.

Wherever worthless, hollow trees were found infested, they were felled and burned. More than one hundred acres of brush and woodland have been burned over, and everything upon it destroyed. Stone walls in which eggs were laid were thoroughly cleaned by fire. In this way vast numbers of moths and their eggs were destroyed during the season.

Banding Trees.

As it was observed early in the campaign that the distribution of the caterpillars was effected largely by their falling from the trees upon teams, an effort was made to destroy all eggs upon trees on or near the highways. Before the hatching of the eggs, many of the large street trees in Malden, most of those in Medford and some in Somerville, were banded with strips of tarred paper. This work was first undertaken in Medford. It was proposed by the selectmen of that town as a means of protecting the street trees from the gypsy moth and the canker worm. It proved a very effective means of preventing the depredations of each of these species. The town furnished the labor and paper for banding the trees in Medford. These strips were kept moist by regular applications of a mixture that the caterpillars could not cross. Great numbers of eggs had been deposited on buildings, fences and other objects near the trees. As soon as the young caterpillars left the eggs, instinct led them to the trees, and, as they crawled upward to find food, many were entangled in the cotton waste under the tarred paper and perished. Many more succeeded in getting upon the paper, and, in cases where they were very numerous, would undoubtedly have bridged the mixture upon the paper with their bodies, until some had passed over. The men employed in applying the mixture from day to day prevented this by killing them with their brushes. Some eggs in the trees which had been missed in the spring doubtless hatched, but most of the caterpillars descended from the tree at one time or another, and were unable to return. This greatly reduced the danger that had seemed imminent in the spring, — that the caterpillars would be distributed in large numbers.

Experimental Work.

Throughout the season no measures were at any time adopted until they had been determined to be effective by experiments in the laboratory and by practice in the field. During the time employed in destroying the eggs a series of experiments was conducted to determine the best method of destroying the caterpillars. A supply was obtained by artificial hatching. The experimental work was continued during the spring and summer. The experiments with Paris green gave the best results. When it was properly applied to plants, all newly hatched caterpillars which were fed upon them in the laboratory died within a few days. In the field similar results were obtained. In the experimental work no injury to the foliage was observed, when a mixture consisting of one pound of poison to one hundred and fifty gallons of water was used. Later, glucose was added to retain the poison upon the foliage.

Spraying with Insecticides.—Paris Green.

When it became evident that Paris green was effective, preparations were made for its use on an extended scale. During the first part of May teamsters were employed, and twenty spraying outfits were put upon the road in Medford. It was soon seen that the number of men and teams was insufficient. Ten additional spraying outfits were purchased, and the effectiveness of all was doubled by improved appliances. In May and June seven superintendents were selected from the force to oversee the work of the men, and to instruct them in the use of the apparatus. One man was given general charge of the teams and implements. Each team and the accompanying squad of men was under the immediate charge of an inspector. When the apparatus had all been thoroughly tested, and the men had attained the skill requisite for its intelligent use, the entire force was sent to the periphery of the region then known to be infested, and all were instructed to work toward the centre. The infested area was thus sprayed until the middle of July. At that time numbers of caterpillars were fully grown and had stopped feeding; some had pupated and others were wandering from tree to tree. Other means were then used to destroy both caterpillars and pupæ.

Police.

When, in May, the caterpillars were seen to be spinning down from the trees, an attempt was made to maintain a cordon of police around the territory most densely infested, with a view to



Gypsy Moth caterpillars gathered on the trunk of a tree.
ARLINGTON, MASS., JULY 9, 1891.

preventing the dissemination of the moth. The police were to stop all vehicles going out of the infested territory, and examine them; to remove caterpillars found on them; to stop all teaming of infested material, and to enforce the regulations of the department. The police outposts were examined by Professor Shaler, who soon saw that the scheme was impracticable, and would not attain the results for which it was intended. Less than two weeks' trial of the system convinced the director of its inefficiency, and it was discontinued by vote of the committee.

Burlapping.

During the spraying season experiments were made with various traps for catching the caterpillars. By observing their habits, it was seen that no trap would be effective unless it could be made to serve as a hiding place. The cavities in trees to which they resorted during the day were first burned out and then filled with cement. This cementing was done in rainy weather, when spraying was impracticable. A band of burlap was placed around the trunk of each tree. The caterpillars crowded under these bands. The men visited them daily and destroyed vast numbers, until all that remained had pupated. In two days a gang of three men killed in this manner 119,896 caterpillars and pupæ. A week after only 5,490 were found in the same locality, and a few days later but 180.

Contact Insecticides.

Early in the season experiments had been made with insecticides for killing the caterpillars and pupæ by contact. Before pupating, the caterpillars gathered in large numbers on the bark and in the cavities of trees. In these situations they were killed by spraying them with emulsions of whale-oil soap, soap powders and other insecticides. Vast numbers were destroyed in this way. In one instance two bushels of dead caterpillars and pupæ were gathered under a few apple trees. In one locality in Swampscott the stench from their decaying bodies was sickening.

In August and September the men were engaged in destroying caterpillars, pupæ, moths and eggs, wherever they were numerous. As soon as all the eggs had been deposited, the force was again reduced in numbers. The expert men who had been retained were all set to work searching for and gathering eggs in the most thickly infested portions of Malden and Medford. There again they were given the training which has been and will be of great advantage in the inspection of other towns. In the mean time they were able to destroy the greatest number of moths possible. This

work was continued until the leaves fell from the trees. In December most of the men were sent into the towns and cities beyond the known infested district, there to continue the inspection, which had been interrupted in the spring by the growing leaves. Eighteen of these towns and three cities have been examined. A few scattered egg-clusters have been found in the three cities and in four of the towns. In these cases there is positive evidence that the moth has been resident two or three seasons. This is a significant fact. It leads us to infer that the work done in the centre has prevented further spreading during the present season.

Condition of the Infested Territory.

The condition of the infested territory in the spring of 1891 was found, by a hasty inspection, to be as follows: In the central part of the town of Medford, on both sides of the Mystic River, the eggs of the gypsy moth were distributed in great numbers over large areas. In the strips of intervening ground there were comparatively few. Perhaps the two most densely infested localities were the Glenwood district, into which the moth was first imported, and the most thickly settled portion on the south side of the Mystic River. The Edgeworth district in Malden was overrun, and on all the roads leading from these districts in Malden and Medford, there were colonies of the pest. In Everett, which adjoins both of these towns, they were widely scattered, and only here and there were they numerous enough to seriously threaten vegetation. The centres of population in all the towns surrounding Malden and Medford were badly infested. From these centres the moths had been distributed upon the highways, and a few were found scattered in the next series of towns to the east, north and west. Thus, while Somerville, Arlington, Winchester, Stoneham, Melrose, Saugus, Revere and Chelsea, which lie nearest to Malden, Medford and Everett, were all considerably infested, Cambridge, Belmont, Lexington, Woburn, Wakefield, Lynn and Swampscott, contained as a rule only scattered and isolated colonies. Some exceptions to this rule may be noted. There was one seriously infested locality in Arlington, near Lexington. There was one in North Cambridge, which contained as many eggs to the square foot as any in Malden or Medford. But the most peculiar instance of a large colony at a distance from the centre was in Swampscott. During the spring inspection isolated nests were found in Charlestown and Lynnfield. This inspection was continued until the foliage became so dense that the search for eggs on the trees was necessarily abandoned, and the spraying was begun.

The purpose of the December inspection was to continue the search in all directions until the limits of the infested territory should be found. In this inspection a wide belt around the infested area was explored. A few egg-clusters were found in Salem, Peabody, Marblehead, Beverly, Reading, Brighton, Watertown and Waltham. One badly infested locality was found on Breed's Island, East Boston. They were also found in Winthrop. To each of these cities and towns, which had not been previously examined, the moth had been disseminated in some way from one to three years before the work of extermination was begun by this department.

Statements and Rumors of its Existence elsewhere in New England.

Many statements have been made from time to time during the season, both by individuals and by the press, that the gypsy moth had appeared in different parts of Massachusetts and in other New England States. Rumors have been magnified and given the importance of facts. Many communications have been received both by the committee and the director from persons outside the infested territory, who feared they had discovered the gypsy moth on their own or adjoining premises. All cases of this kind which have come directly or indirectly to our notice have been fully investigated, and the depredations noticed have always been attributable to other insects. No evidence of the gypsy moth has been found.

Towns and Cities examined where no Moths were found.

During the season the routes of traffic and travel have been carefully studied, and all clues which might lead to the discovery of the moth in towns beyond the district known to be infested have been followed. The following is a list of the towns and cities which have been partially inspected in following these clues, and in which nothing has been found : —

Worcester,	Lawrence,	North Reading,
Spencer,	Brookton,	Wilmington,
Leicester,	Dorchester,	Bedford,
Clinton,	Centre Harbor, N. H.,	Concord,
Lancaster,	Athol,	Lincoln,
Milford,	Gloucester,	Newton,
Holden,	Manchester,	Brookline,
Lowell,	Wenham,	Wayland,
Ashburnham,	Danvers,	Weston.

Number of Men Employed.

The force was increased in numbers as the men could be selected and trained. The increase continued until all spraying outfits were in the field. When the spraying season closed the force was reduced by the discharge of teamsters and laborers. The more skilled workmen were retained, and employed in destroying caterpillars and pupæ, until all the moths had laid their eggs. Then a further reduction was made, and only those most efficient in egg-gathering were retained.

Number of Men Employed Each Week.

March 20 and 21,	16	August 10-15,	98
March 23-28,	40	August 17-22,	96
March 30-April 4,	103	August 24-29,	88
April 5-11,	129	August 31-September 5,	83
April 13-18,	140	September 7-12,	75
April 20-25,	146	September 14-19,	73
April 26-May 2,	167	September 21-26,	67
May 4-9,	173	September 28-October 3,	62
May 11-16,	199	October 5-10,	58
May 18-23,	195	October 12-17,	58
May 25-30,	211	October 19-24,	61
June 1-6,	238	October 26-31,	59
June 8-13,	242	November 2-7,	44
June 14-20,	211	November 9-14,	44
June 22-27,	217	November 16-21,	45
June 29-July 4,	209	November 23-28,	43
July 6-11,	192	November 30-December 5,	41
July 13-18,	170	December 7-12,	41
July 20-25,	104	December 14-19,	42
July 27-Aug. 1,	106	December 21-26,	42
August 3-8,	99	December 28-January 2,	42

Results of the Season's Work.

The work which has been carried on during the season has been so effective that all the large colonies of the moth have been destroyed. Where in past seasons the trees bore neither leaves nor fruit, this year a good crop has been realized. In fact, many trees have broken down under their loads of fruit. Where last season thousands of eggs were seen upon the trees, now very few can be found. There is still a large area in which the eggs have not been destroyed. This should be searched with the utmost care before the leaves come again.



View of woodland infested by the Gypsy Moth.
SWAMPSCOTT, MASS., AUGUST 5, 1891.

Summary.

Following is a summary of such results of the work as can, from their nature, be accurately recorded. Much spraying, cutting and burning of brush, of which no accurate figures could be made, was done from time to time, and there was much incidental labor required in inspecting and cleaning, the results of which cannot be tabulated. The figures given are for work done from April 1, 1891, to Jan. 1, 1892.

Trees.

Number inspected,	.	.	.	.	.	.	.	.	3,591,982
Number infested,	.	.	.	.	.	.	.	.	213,828
Number cleaned of eggs,	.	.	.	.	.	.	.	.	212,432
Number sprayed,	.	.	.	.	.	.	.	.	177,415
Number cemented,	.	.	.	.	.	.	.	.	19,296
Number burlapped,	.	.	.	.	.	.	.	.	68,720
Number banded,	.	.	.	.	.	.	.	.	12,000

Buildings.

Number inspected,	.	.	.	.	.	.	.	.	87,536
Number infested,	.	.	.	.	.	.	.	.	3,647
Number cleaned of eggs,	.	.	.	.	.	.	.	.	3,574

Fences.

Number inspected,	.	.	.	.	.	.	.	.	53,219
Number infested,	.	.	.	.	.	.	.	.	6,808
Number cleaned of eggs,	.	.	.	.	.	.	.	.	6,570

A conservative estimate, based on the daily reports, has shown the number of egg-clusters destroyed during the first six weeks of the season to be 757,760; the average number of eggs in each cluster is 468; thus 353,031,680 eggs were destroyed during that time and other millions would have been gathered had they not hatched.

The number of egg-clusters gathered during October, November and December, 21,623, represents, probably, about one-third of those deposited upon the trees this fall. It will be seen by these figures that the vast increase of the moth has been checked, and only about one-tenth as many egg-clusters were found this fall as were gathered in the spring.

The Destructiveness of the Moth.

Owing to the reduction of their numbers by the measures taken during the past season, the only favorable opportunities of observing the voracity of the gypsy moth caterpillars were in two locali-

ties: one in Arlington and the other in Swampscott. They were not discovered in these places until they were far advanced in the work of defoliating the trees. In Swampscott they stripped the foliage from both evergreen and deciduous trees of all species, and even ate portions of the twigs. They did this in the face of prompt and vigorous measures which were taken to check their ravages. Fire was used as a last resort. They destroyed the foliage of shrubs, vines and all growing vegetation, even attacking the herds-grass in the fields. They spread over ten acres of woodland, and stripped a large part of it before they were checked. It is said that in Medford they destroyed all the foliage in many orchards in some previous seasons, although the owners did all in their power to stop them. From the evidence of trustworthy residents it would seem that the gypsy moth, where abundant, moves like the army worm, destroying all vegetation as it goes.

Obstacles to Extermination.

There are many circumstances connected with the life-history of this insect which must be taken into consideration in planning for its destruction. Such of these as directly and materially affect our plans are given below, with their bearing on the question of extermination:—

1. The enormous increase. The female lays a large number of eggs. These eggs are protected by a covering composed of hairs from the body of the female, and are usually deposited in sheltered situations. Under favorable conditions nearly all the eggs hatch, and, as the young caterpillars are very tenacious of life, a large proportion come to maturity.

2. Where abundant, it is found on nearly all plants of economic importance, whereas many other insects confine themselves to a few plants.

3. The long season during which it feeds. The eggs hatch from April to the last of June, and the caterpillars feed during May, June, July and August. If one crop of caterpillars be destroyed, another will follow, and the entire infested district must be gone over again and again, while the men are engaged in spraying, or destroying the caterpillars by other means.

4. The wandering habits of the caterpillars. In thickly infested regions, wherever the trees become overcrowded and much effort is required to find food, many of them become restless, and wander in all directions. At such times the slightest disturbance will cause them to spin or drop down from the branches and attach themselves to moving objects. They are thus carried to a distance.

5. The most densely infested areas correspond nearly with the

centres of population. These centres are settled largely by small householders. Flower, fruit and vegetable gardens and small orchards are abundant. The difficulty of carrying on destructive work to good advantage in such localities is evident.

Circumstances which Favor Plans for Extermination.

1. The most important and favorable circumstance of all is that the moth is apparently confined to a limited area.

2. The location of the infested territory. The eastern and a large portion of the southern part of the infested territory is bounded by the sea. This prevents all danger of the spreading of the moth in these directions. The territory most infested is frequently crossed by tidal rivers, which form a perfect barrier to migrations of the insects, except where they can cross the streams on bridges. A large part of the territory along the coast consists of salt marsh, and in this the gypsy moth has not been found, and probably could not live.

3. The moth was imported more than twenty-one years ago, and has now been found in less than thirty towns. This shows that it has not spread rapidly.

4. Travel and traffic in the infested territory moves largely to and from Boston. The business portion of Boston offers very little sustenance to leaf-eaters.

5. There are almost no exports by sea from this district, and the chances of the insect being distributed by the coast trade are therefore very few.

There are certain known habits of the gypsy moth which may be taken advantage of in making plans for its destruction: —

1. The female does not fly except diagonally downward; this greatly lessens the risk of spreading.

2. Where there are few moths, and food is abundant, they are likely to remain in the same locality.

3. The gypsy moth passes the winter in the egg, and remains in this form during the greater part of the fall, winter and early spring. At this time, when the foliage has fallen from deciduous trees, the eggs may be destroyed.

4. In the outlying districts, where the insects are few, the eggs are found almost entirely upon a few species of trees. Thus, if their numbers are greatly reduced, it is probable that they, like many other insects, will select as food certain trees and shrubs, and can be found and destroyed with comparative ease.

A careful weighing of the circumstances favorable to extermination, and those which appear unfavorable, leads to the conclusion that the greatest difficulty is experienced after the caterpillar is

hatched and on the move. This obstacle must always be overcome by destroying the eggs, so that no caterpillars may emerge. Experience has shown that this is the most practical method of dealing with the moth. The chief objection urged to this method is, that some of the eggs are now laid where it is impossible to get to them. A few clusters of eggs here and there will at first escape the general destruction. When few remain, however, nature will aid materially in extermination. It has been stated that the creatures have spread over a comparatively small area in twenty-one years or more. They migrate slowly by a gradual increasing and spreading of the main body, and are thus very destructive. Recent investigations in the territory outside of the thickly infested district have furnished us with a series of data from which we glean the following: —

1. We find that many egg-clusters are infertile.
2. Some that are fertile have not hatched.
3. Others, that have evidently hatched and gone through their transformations, have apparently never reproduced.
4. In other cases the entire colony has been destroyed in some manner during its first or second season.

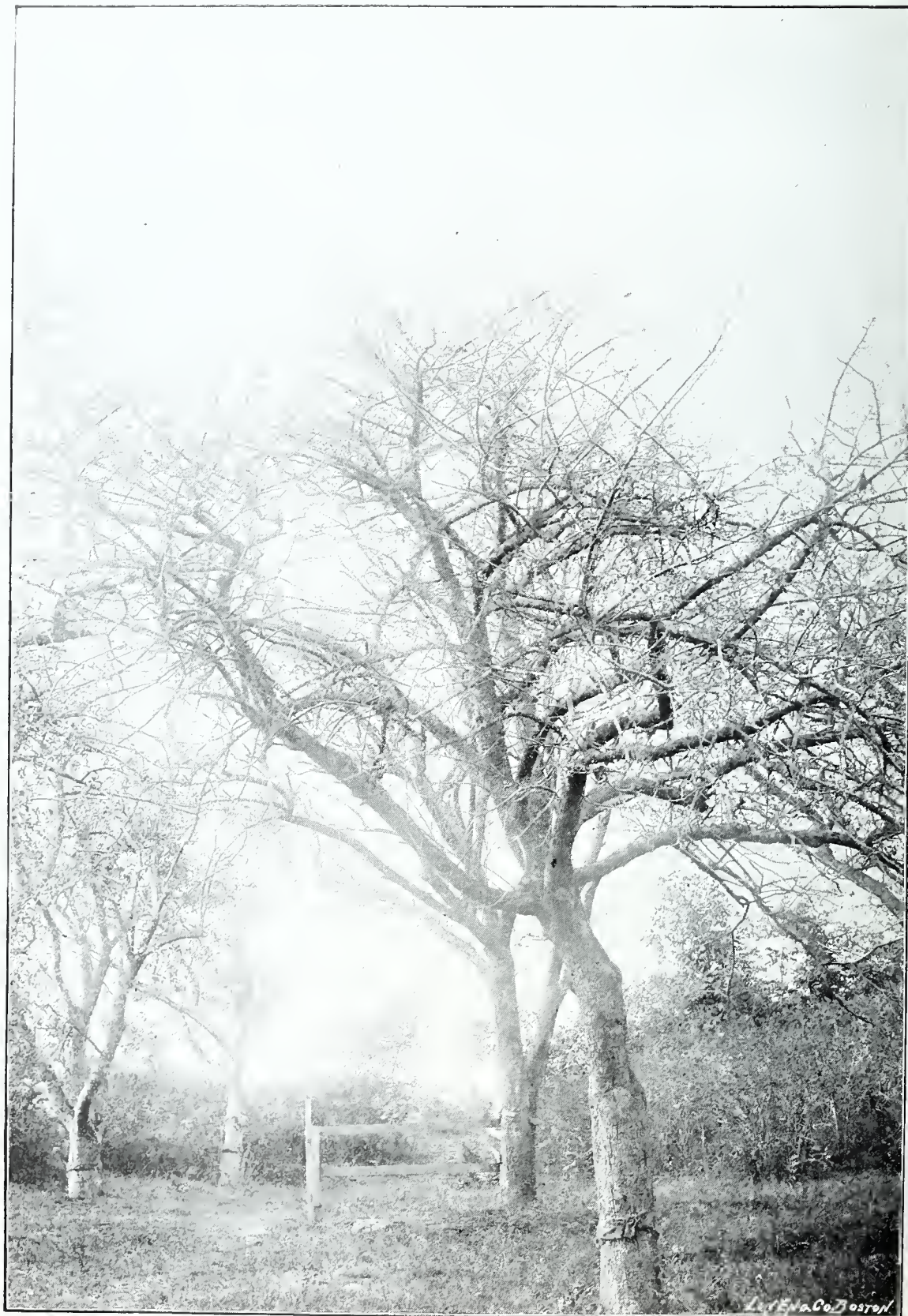
In many cases where the eggs have proved fertile the rate of increase in numbers has been very small during the second and third years. In fact, the instance where an isolated colony greatly increases in the first few years appears to be the exception.

Eggs are infertile where the female which has deposited them has been carried beyond the reach of males of the same species. Predatory larvæ attack the eggs of these and other insects, and, where only one or two eggs-clusters are found by these larvæ, they are generally utterly destroyed. Minute insects of various kinds also destroy them. As soon as the caterpillars are hatched they are exposed to the vicissitudes of our New England climate and to the attacks of birds and parasitic insects. In the smaller suburban towns, where the English sparrow is not abundant, our native birds destroy vast numbers of injurious insects. During the past season, thirteen species of birds have been observed to feed on the gypsy moth in all its stages.

Experience has demonstrated that where a species is reduced in numbers to a few individuals, and those individuals isolated, the chances are in favor of their extermination by natural causes. It is our hope and purpose to so reduce the numbers of the gypsy moth that extermination may eventually be accomplished.

Respectfully submitted,

E. H. FORBUSH,
Director of Field Work.



Apple orchard stripped by caterpillars of the Gypsy Moth.
SWAMPSCOTT, MASS., AUGUST 5, 1891.

ENTOMOLOGIST'S REPORT.

To the Members of the Gypsy Moth Committee.

GENTLEMEN : — Upon receiving the appointment of entomological adviser from you last June, I visited Malden and other localities infested by the gypsy moth, and made a careful inspection of the work of destroying this insect. Repeated visits were made during the summer and fall, as often as my time would allow or the circumstances seemed to require. So far as I could judge, the work was carried on in the most practical, efficient and economical manner, and the results obtained were all that could be expected, considering the magnitude of the undertaking.

It was not expected that the insect could be exterminated in a single year; the most sanguine person who went over the infested territory and saw the obstacles to be overcome must have realized that it would be the work of time, and would be attended with great expense.

Much has been learned concerning the habits of the insect, which will prove of great value in the field work next year; and many species of native parasites have been discovered destroying the gypsy moth during the past summer, some of which have proved to be among the most useful in destroying or holding our native injurious insects in check, while others have proved to be new to science. It should be remembered that parasites, when left to themselves, do not wholly exterminate an insect pest, but that they reduce its numbers greatly, thus aiding the work of destruction. It is not wise, therefore, to leave the work of destruction to the parasites, but to so conduct the work that all the assistance they can give may be secured.

It would be a very grave mistake, in my judgment, to abandon the work of destroying the gypsy moths; but by far the wisest course to pursue will be to make so liberal an appropriation that the work may be carried on in the most vigorous manner over the entire territory, and so reduce the number of moths and extent of territory by local extermination as to cause the work to decrease in extent year by year, and therefore in expense. This is undoubtedly a case where very liberal appropriations at first will prove the most economical in the end.

That the presence of this insect in eastern Massachusetts is a great evil, and expensive to our taxpayers, no one will deny; but, if it should spread over the entire State, it will prove a far greater evil, and its extermination an utter impossibility; therefore, of these two evils it seems to me to be wise to choose the

least, and employ skilled men to fight the pest where it now is, for our chances of exterminating the insect lie only in this direction. There are some who think the insect can never be exterminated; but, if this should prove true, it would even then be far cheaper to make an annual appropriation and employ experienced men to fight the pest in its present restricted territory, than to suffer it to spread over the entire Commonwealth and country, and depend upon our farmers to fight the pest, — or neglect it, as is done too frequently with other insects.

I have elsewhere published an estimate of the cost to our Massachusetts farmers of applying Paris green to the potato crop alone for the destruction of the potato beetle, and the amount was \$76,000 annually. The gypsy moth, as is well known, feeds on nearly all of our trees and other plants; and, as a result, the cost of fighting this pest, if spread over the State, will be vastly greater than that of the potato beetle. Will it be wise, therefore, to allow this destructive pest to extend beyond its present limits?

I have given the most careful thought and consideration, as well as such supervision as my time would allow, to the entire work of destroying the gypsy moth during the past season, and have made frequent reports to your committee. I now feel that everything has been done that was possible, under the circumstances, and I would at this time recommend that the work be carried on next year in the same manner as it has been done this year, but on a more extensive plan, and, if possible, with more vigor.

Respectfully submitted,

(Signed)

C. H. FERNALD

